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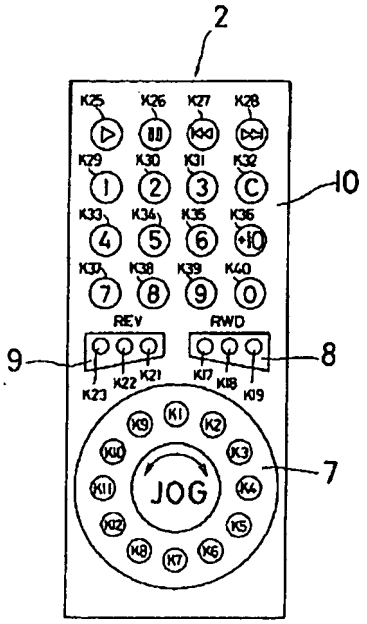
(54) [Title of the Invention] Membrane Switch Provided with a Jog Function

(57) [Abstract]

[Object] With respect to a membrane switch provided with a jog function[1], to provide a compact and low-cost switch.

[Constitution] [The invention] constitutes a printed wiring board having fixed electrodes forming a key matrix and a flexible sheet affixed to the surface of a printed circuit board with moveable electrodes attached at positions corresponding to key positions, while a microprocessor is constituted so as to recognize the direction of movement and movement speed at the time that the keys on the surface of the flexible sheet are manipulated, and provide output of codes corresponding to these various values.



[1] In this document, the terms "jog function" and "jog operation" refer to an analogue of the rotary motion of a knob such as that used to control variable-speed fast-forward or rewind operations in a VCR. The term comes from "jogging," which is a technique for generating motion in a motor, e.g., the tape drive motor. – Translator.

[Claims]

[Claim 1]

A membrane switch provided with a jog function comprising: a flexible sheet upon which are formed movable electrodes corresponding to a plurality of keys; and a printed wiring board upon which are formed fixed electrodes corresponding to said movable electrodes; where said flexible sheet and printed wiring board are laminated and aligned so that said movable electrodes and fixed electrodes face each other with a stipulated spacing maintained between, wherein:

said membrane switch is provided with a jog function characterized in that, when any of the keys upon said membrane switch is pressed, its key signal is detected and when a plurality of keys is determined to be continuously ON within a stipulated period of time, codes corresponding to a direction of movement and speed of movement of the ON keys are provided as output.

[Claim 2]

The membrane switch provided with a jog function as in claim 1, characterized in that said plurality of keys are disposed upon concentric circles.

[Claim 3]

The membrane switch provided with a jog function as in claim 1, characterized in that codes corresponding to the direction of movement and speed of movement of the ON keys are codes that are preset in a microprocessor.

[Claim 4]

The membrane switch provided with a jog function as in claim 1 or 2, characterized in that said plurality of keys each has a unique key characteristic, and are disposed upon the same substrate as remote control switches.

[Detailed Description of the Invention]

[0001]

[Industrial Field of Utilization]

The present invention relates to a sheet-type membrane switch provided with a jog function.

[0002]

[Prior Art]

Switches provided with a jog function have come to be widely utilized in remote control for the purpose of programming and editing in VCRs, CD players, videodisk players, DAT players and the like.

[0003]

An example of a conventional switch provided with a jog function and used for the aforementioned applications is that shown in Fig. 9. This switch provided with a jog function has an inner shaft 50 and an outer shaft 60, in a structure where inner shaft 50 has a jog function and outer shaft 60 has a shuttle function.

[0004]

The basic mechanism of this type of switch provided with a jog function is its rotary encoder. For example, in jog mode, such a switch can send 16 different codes from its four output terminals, each of which sending a binary signal, so a specified control code can be sent from within a fixed time interval.

[0005]

The problem with this type of switch with a jog function is that, because of its complex mechanical structure, it is difficult to manufacture in a small size and at a low cost.

[0006]

[Problem to be Solved by the Invention]

The present invention has as its object to achieve a thin and low-cost digital switch by implementing the complex mechanical structure of a conventional switch equipped with a jog function by means of an electrical structure and software processing as much as possible.

[0007]

[Means of Solving the Problem]

The membrane switch equipped with a jog function according to the present invention is:

a membrane switch provided with a jog function comprising: a flexible sheet upon which are formed movable electrodes corresponding to a plurality of keys; and a printed wiring board upon which are formed fixed electrodes corresponding to said movable electrodes; where said flexible sheet and printed wiring board are laminated and aligned so that said movable electrodes and fixed electrodes face each other with a stipulated spacing maintained between, wherein:

said membrane switch is provided with a jog function characterized in that, when any of the keys upon said membrane switch is pressed, its key signal is detected and when a plurality of keys is determined to be continuously ON within a stipulated period of time, codes corresponding to a direction of movement and speed of movement of the ON keys are provided as output. In addition, said plurality of keys are disposed upon concentric circles. In addition, codes corresponding to the direction of movement and speed of movement of the ON keys are codes that are preset in a microprocessor. In addition, said plurality of keys each has a unique key characteristic, and are disposed upon the same substrate as remote control switches.

[0008]

[Operation]

With a membrane switch provided with a jog function having the aforementioned constitution, when one of the keys disposed on the surface of the flexible sheet is pressed with a finger or the like, the moveable electrode at that key position on the back surface of the flexible sheet is pushed downward and as a result, comes in contact with the fixed electrode directly below that movable electrode, causing that key to be turned ON and thus the key position of the pressed key is detected.

[0009]

In addition, when the "jog" operation of pressing a plurality of keys sequentially at a certain speed in a certain direction is performed, the combination of the numbers of the plurality of keys that were turned ON sequentially, the sequence in which they were turned ON, and the number of keys that were turned ON within a unit time are used to determine the direction of movement and speed of movement in the jog operation, and thus corresponding codes are provided as output.

[0010]

By disposing a membrane switch provided with a jog function upon the same substrate as remote control switches, it is possible to make the device compact while permitting the user to perform such operations as turning the power on/off and changing channels, as well as performing fast-forward, rewind and other operations at variable speeds.

[0011]

[Preferred Embodiment]

Here follows a detailed description of a preferred embodiment of the present invention made with reference to the drawings. A membrane switch provided with a jog function according to the present invention may be used, for example, as a remote control. It comprises a printed wiring board 1 laminated to a flexible sheet 2 as shown in FIG. 1.

[0012]

A microprocessor 3 is built into the back surface of wiring board 1. Printed wiring board 1 includes a plurality of wires 4, 5, and 6 printed on its front surface to form a matrix, as described below. Microprocessor 3 and printed wires 4, 5, and 6 are connected via through holes in printed wiring board 1.

[0013]

Flexible sheet 2 consists of a very thin sheet (for example, 280 microns) made from polycarbonate or polyester. A jog key area 7, shuttle key areas 8 and 9, and a general key area 10 are disposed on the surface of flexible sheet 2 as shown in FIG. 2.

[0014]

A key position or key number is assigned to each key. To wit, for the jog keys, each key is positioned in the jog key area 7 upon concentric circles. A total of 12 key numbers are assigned to these keys: keys K1–K6 clockwise, beginning with the uppermost key position K1, and keys K9–K14 counterclockwise from the uppermost key position K1.

[0015]

A total of six shuttle keys are provided, three forward-direction (FWD) keys K17–K19 in shuttle key area 8, and three reverse-direction (REV) keys K21–K23 in shuttle key area 9. For the general keys, 16 keys K25–K40 are provided in general key area 10. Each of these general keys has a specific function, such as turning the power on or off, changing channels, or switching between television and tape recorder mode.

[0016]

Referring to FIG. 3, movable carbon electrodes Ci (where i is the number that identifies the key) are printed on the back of flexible sheet 2 in all the key positions. A fixed carbon electrode (not shown) is printed on wiring board 1 opposite each carbon electrode Ci. The area around carbon electrodes Ci (where i=1 to 40) is raised slightly by embossing or other means so that, when wiring board 1 and flexible sheet 2 are laminated together, the movable electrodes are normally not in contact with the fixed electrodes.

[0017]

Referring to FIG. 4, the jog key area 7 is surrounded by an outer rib 7a about the outside of the concentrically arranged keys K1–K14. An inner rib 7b surrounds the inside. The space between outer rib 7a and inner rib 7b is raised above the surface of wiring board 1. Movable carbon electrodes C1–C14 are affixed to the inside of the raised space. The space between outer rib 7a and inner rib 7b is set so that a person's finger fits comfortably therein and can move around the keys easily.

[0018]

When a key Ki (i=1 to 40) on the surface of flexible sheet 2 is pressed by a person's finger, the pressed key forms a depression because flexible sheet 2 flexes. As a result the corresponding carbon electrode Ci comes into contact with a fixed electrode on wiring board 1. When the finger is lifted, flexible sheet 2 restores the carbon electrode Ci to its former position. In other words, the carbon electrode Ci performs the function of the short-circuiting electrode of a switch.

[0019]

Referring to FIG. 5, the circuitry of wiring board 1 is arranged as follows. A wire group 35 and a wire group 36 are printed on wiring board 1 near each other as fixed electrodes in each key area. Each intersection of wire groups 35 and 36 corresponds to a key position K1–K62. That is, in terms of circuitry, the key positions K1–K62 form a matrix.

[0020]

Wire group 35 is connected to multiple scan-in ports SIN of microprocessor 3. Wire group 36 is connected to multiple scan-out ports SOUT of microprocessor 3.

[0021]

Referring to FIG. 6, the two printed wires that intersect at each key position Ki are connected ("key on") or separated ("key off") by carbon electrode Ci, thus forming an on/off switch.

[0022]

At regular intervals, microprocessor 3 performs a key scan-in of the SIN ports and a key scan-out of the SOUT ports, Namely, microprocessor 3 sequentially outputs signals at a low level L from ports SOUT and sequentially checks ports SIN for the presence of input signals at low level L.

[0023]

When all keys are off, all SIN ports are at a high level H, and microprocessor 3 is in standby. If a key is closed, the corresponding SIN port goes to a low level L. As a result, microprocessor 3 detects the position of the key that has closed, shifts into a wakeup state, and executes a prescribed program.

[0024]

Microprocessor 3 has, in addition to what has been described above, a power source terminal Vcc, a ground terminal Vss, and a reset terminal RESET. In addition, a mode switch 31, a clock circuit 33, and a remote control output circuit 34 are attached to microprocessor 3.

[0025]

When mode switch 31 is closed, microprocessor 3 goes into shuttle mode. When mode switch 31 is open, microprocessor 3 goes into jog/shuttle mode.

[0026]

Clock circuit 33 generates a clock pulse (at, for example, 960 kHz) from oscillator 32 that sets the timing for the cycles of microprocessor 3.

[0027]

In addition, remote control output circuit 34 emits remote control signals, such as infrared signals, that are controlled by the output codes of microprocessor 3 if the membrane switch of this invention is used as a remote control device.

[0028]

The jog function determines the direction and speed of shift of the fingers that press the keys on the surface of flexible sheet 2, based on the sequence in which jog keys K1–K6 and K9–K14 come on and the number that come on within a unit time interval.

[0029]

There is no specific trigger key that initiates the jog function. When any of keys K1–K62 is turned on, microprocessor 3 shifts from standby to wakeup.

[0030]

Output from the jog function begins after the direction of rotation in the jog operation has been established. A jog operation is deemed to have begun when three keys, including the first very pressed, are pressed in succession. At the same time the direction of rotation is recognized. And, when the first key pressed is switched to the on state, detection begins of the number of keys that are switched on per unit time, as described below.

[0031]

Thereafter, while only the direction is recognized, a code is transmitted that corresponds to the count of the number of keys turned on within the prescribed time (for example, in this embodiment, 90 ms is the time in which remote control signals are sent, the same as the time for transmission of a single frame).

[0032]

To wit, microprocessor 3 determines the code to be transmitted by counting the number of jog keys K1–K14 that are turned on one after another during a prescribed time interval, as in the following table. The key scanning period here is set to 10 ms.

[0033]

[Table 1]

Jog Operation		Number of Keys Turned On During Prescribed Interval	Output Code
Clockwise	Low speed	1	20
	|	2–3	21
	|	4–5	22
	High speed	6+	23
Counterclockwise	Low speed	1	24
	|	2–3	25
	|	4–5	26
	High speed	6+	27

[0034]

The following example explains the operation of the jog function. If key K2 is pressed first, as soon as that happens, microprocessor 3 goes into the wakeup state, and scan signals are generated at 10 ms intervals from terminals SOUT. If key K3 is then pressed, no control code is transmitted. If, following that, key K4 is pressed, microprocessor 3 recognizes a jog operation.

[0035]

If, within the prescribed time of 90 ms from the initial pressing of key K2, keys K3, K4, and K5 are also pressed, a code of "22" will be transmitted, as shown in Table 1 above. If thereafter keys K6, K14, and K13 are also pressed within the same 90 ms, a code of "23" will be transmitted.

[0036]

Processing of key presses is controlled so that microprocessor 3 ignores two successive presses on the same key, as, for example, because of chattering. Microprocessor 3 also ignores the signal if adjacent keys are doubly pressed and if adjacent keys are alternately pressed.

[0037]

If, while one key remains pressed, motion is reversed without lifting the finger, the key that moved in the reverse direction is not immediately counted. This is because it is deemed to be the same key, as when adjacent keys are pressed alternately, as explained above. Only when a new key is pressed in the reverse direction is it recognized, and the code for the lowest speed in that reverse direction is then transmitted. For example, if the keys are pressed in the sequence K2→K3→K2→K1, the sequence of K2→K3→K2 is recognized as only one key. If key K1 is pressed immediately thereafter, microprocessor 3 recognizes that a operation has been made in the reverse direction (counterclockwise).

[0038]

The jog keys are normally turned on in succession, but it is conceivable that keys could be turned on discontinuously through rapid motion. In such an event, microprocessor 3 deems the skipping over of one key to be the same as a continuous pressing of successive keys, and the count of keys pressed is incremented by 1.

[0039]

In jog mode, the output of the code shown above in Table 1, together with a code indicating the direction of the jog operation, is modulated on an infrared signal and transmitted by the same means and with the same timing as when another general key is pressed.

[0040]

When all the jog keys are switched off, then, after a fixed time, the jog mode is canceled, and the transmission of output codes terminates.

[0041]

The shuttle function in jog/shuttle mode is carried out by successively pressing keys in the forward-direction shuttle key area K17–K20 or in the reverse-direction shuttle key area K21–K24.

[0042]

In each of these key areas, double pressing is allowed. If two keys are pressed successively, the code corresponding to the higher-numbered key (for K17 and K18, that key is K18) is transmitted.

[0043]

When the shuttle keys have been off for the prescribed time (100 ms), the "key off" state is recognized. At this time the shuttle function is canceled and the transmission of codes is terminated.

[0044]

Regarding the timing and format of code transmissions from general keys, transmission is carried out while a key is on and blocked when the keys are off.

[0045]

The foregoing describes the jog/shuttle function for an embodiment that uses specialized jog keys and shuttle keys, but specialized keys need not be provided.

[0046]

In another embodiment, a general-use key area can also perform jog/shuttle operations. For example, referring to FIG. 2, it would suffice to write a program for microprocessor 3 so that jog/shuttle operations could be carried out with eight keys that remain after eliminating some of the keys (for example, the four corner keys) and the four central keys in the general key area.

[0047]

In the above embodiment, the speed of the jog operation was turned into a specific output code. One could also transmit a specific code that depends on the acceleration

(rather than the speed) of the jog operation. Also, in the membrane switch of the above embodiment, the spacing between the fixed and movable electrodes is maintained by embossing flexible sheet 2, but one could insert a separate spacer between them instead.

[0048]

Referring to FIG. 7, in a second embodiment of the present invention, multiple keys 21–24 are distributed in a ring-shaped area 20 around a center key and given composite functions that correspond to successive key-on operations and individual key-on operations.

[0049]

Referring to FIG. 8, in a third embodiment of the present invention, jog operations are performed automatically in contrast to the jog operations that were performed with the finger in the embodiments above.

[0050]

Specifically, a shaft 40 that vertically pierces wiring board 1 and flexible sheet 2 is provided in the central position of the ring of the jog area 7. Affixed to the upper end of shaft 40 is the center of a disk 41 that can rotate freely. In this embodiment, flexible sheet 2 is supported by a horizontal plate 42 affixed to shaft 40.

[0051]

At one spot on the outer rim of disk 41 is a downward-pointing spherical protrusion 43. With such a structure, when disk 41 makes a jog motion, the key positions of flexible sheet 2 are pressed by protrusion 43. This pressure bends them successively downward, thereby causing carbon electrodes Ci to come into contact successively with printed board 1, turning keys on in succession.

[0052]

In the foregoing we have described an embodiment in which the membrane digital switch of the present invention is applied to a remote control. However, the idea of the present invention is to recognize the amount of motion and speed of motion in a jog operation and to transmit codes that correspond to combinations of recognized parameters, by providing a microprocessor and printed wirings on a wiring board, laminating onto the surface of this wiring board a flexible membrane on which are arranged carbon electrodes Ci in the key positions, and using the microprocessor to detect jog operations on the surface of the membrane.

[0053]

Thus the present invention can be applied widely in the field of mechanical devices, not only to remote control devices, to transmit codes according to the direction and speed of key operations on the surface of a membrane.

[0054]

[Meritorious Effects of the Invention]

As explained above, the membrane switch provided with a jog function according to the present invention is a very thin and compact membrane switch with a simple structure in which fixed electrodes attached to a microprocessor and a printed wiring board are laminated together with a flexible sheet to which movable electrodes are affixed in key positions. Thus the switches of the present invention are thinner and less expensive to make than the switches currently available.

[0055]

In addition, the switch of the present invention can be combined with, for example, specific switches for changing channels in a remote control. Along with making it possible to use scanning to change the speed, as between fast forward and rewind, with a single remote control device, the device of the present invention can be made smaller than remote-control devices presently in use.

[Brief Description of the Drawings]

[FIG. 1] This is an exploded perspective view of the overall structure of the switch of the first embodiment of the present invention.

[FIG. 2] This is a top view of the flexible sheet of the switch of FIG. 1.

[FIG. 3] This is a bottom view of the flexible sheet of the switch of FIG. 1.

[FIG. 4] This is a cross-sectional view of FIG. 2 along IV–IV.

[FIG. 5] This is a circuit diagram for the printed wiring board of the switch of FIG. 1.

[FIG. 6] This is a diagram that shows what happens in the circuit of FIG. 5 when a key is pressed on the switch of FIG. 1.

[FIG. 7] This is a diagram of a second embodiment of the present invention.

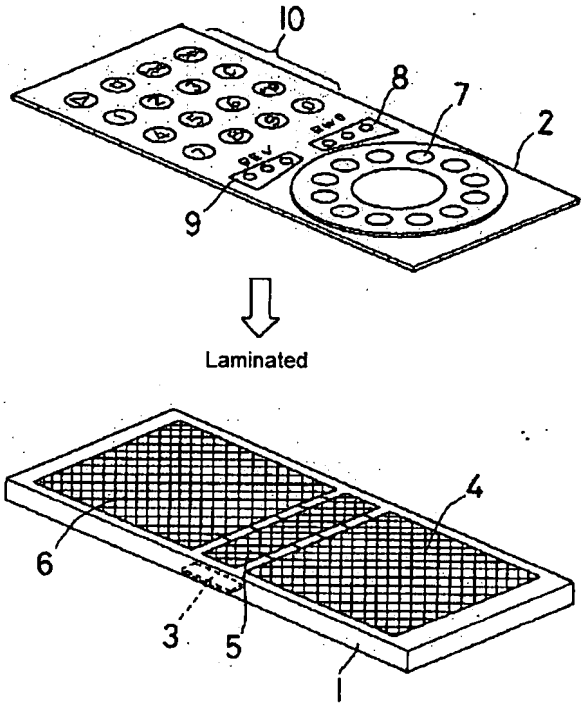
[FIG. 8] This is a diagram of a third embodiment of the present invention.

[FIG. 9] This is a perspective view of the switch of the prior art.

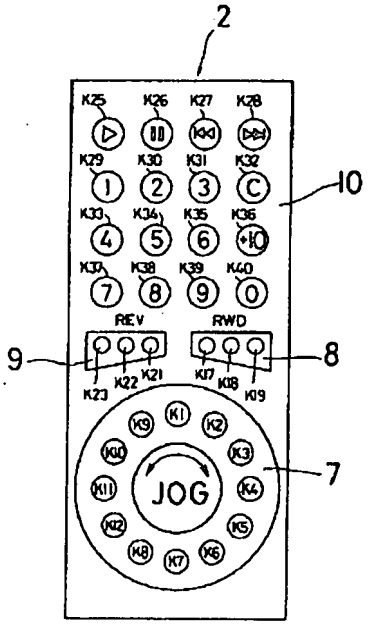
[Explanation of Symbols]

1 Printed wiring board
2 Flexible sheet
3 Microprocessor
4, 5, 6 Printed wires
7 Jog key area
7a Outer rib
7b Inner rib
8, 9 Shuttle key area
10 Key area
20 Ring-shaped region
21–24 Keys
31 Mode switch
32 Oscillator
33 Clock circuit
34 Remote control output circuit
35, 36 Wire groups
50 Inner shaft
60 Outer shaft
Ci Carbon electrodes
Ki Keys

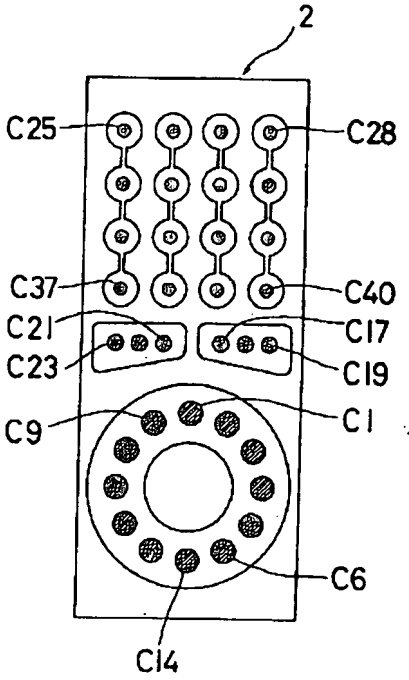
[FIG. 1]



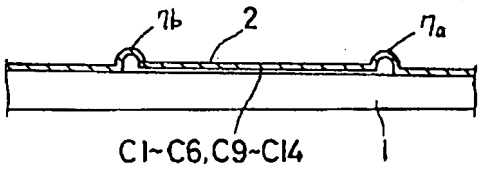
[FIG. 2]



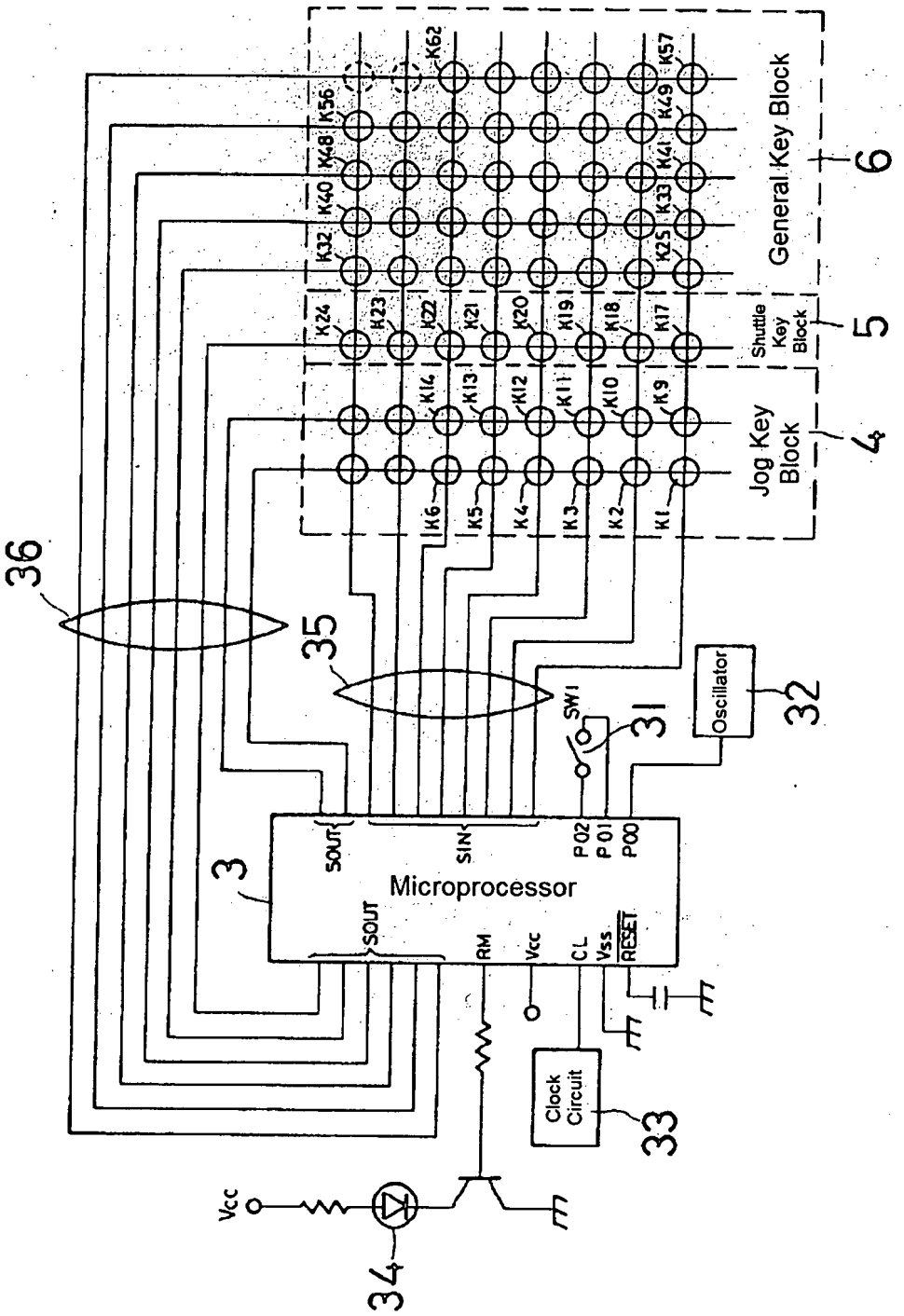
[FIG. 3]



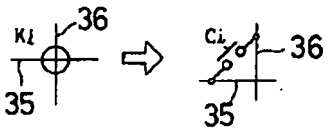
[FIG. 4]



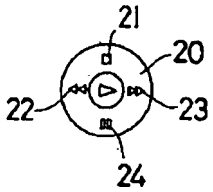
[FIG. 5]


General Key Block
6
Shuttle Key Block
5
Jog Key Block
4
K62
K57
K56
K49
K48
K41
K40
K33
K32
K25
K24
K23
K22
K21
K20
K19
K18
K17
K14
K13
K12
K11
K10
K9
K6
K5
K4
K3
K2
K1
36
35
SW1
31
Oscillator
32
3
SOUT
SIN
P02
P01
P00
Microprocessor
SOUT
RM
Vcc
CL
Vss
RESET
Clock Circuit
33
Vcc
34

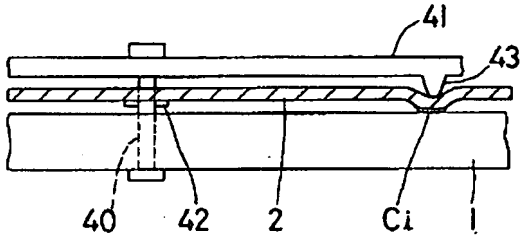
[FIG. 6]



[FIG. 7]



[FIG. 8]



[FIG. 9]